A novel approach to mitigate fish downstream migration at hydropower plants

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At hydropower plants (HPPs), the fish downstream migration is related to fish passage through the turbines which can result in serious injury and mortality rates of the fish and endanger fish populations. Apart from special fish species and HPP sites, the most common and reliable approach for fish protection and downstream passage at HPPs are mechanical barriers, typically fine screens, in combination with bypass systems. This is related to high constructional efforts, intense maintenance, reduced electricity production and in many cases the feasibility is not given.

An alternative approach was developed at the Technical University of Munich (TUM), the “Induced Drift Application” (IDA). Experimental investigations and fish damage rate modelling indicate, that fish damage rates depend on the fish behavior during turbine passage. A targeted manipulation of the fish behavior could thus be employed to reduce damage rates. The particular fish sensitivity to electric fields, especially electro-taxis and electro-narcosis, provide favorable options for this purpose. A European patent was granted for fish protection techniques by behavior manipulation.

Within the Fithydro EU Horizon 2020 project a first experimental investigation of the IDA approach was conducted at the TUM. Competitive turbine passage tests with two different behavior stimuli and an undisturbed reverence group were carried out. 1200 brown trout of different size classes passed through a Kaplan turbine for different operating points. The detailed registration of fish injury and mortality included a 96 h observation period to account for ling term damage. All tests were conducted in accordance with life animal welfare regulations and the specific bioassay permit.

The results confirm the influence of fish behavior on fish damage rates during turbine passage and the technical feasibility of the IDA technique. For the given small-scale test facility a reduction of 55 % was obtained. In general, the magnitude of damage rate reduction depends on the turbine specifications and further potential can be expected for larger turbine setups. The IDA technique provides perspective for cost-efficient ecological improvements of fish downstream migration at HPPs, especially for large scale and retrofitting at existing sites.